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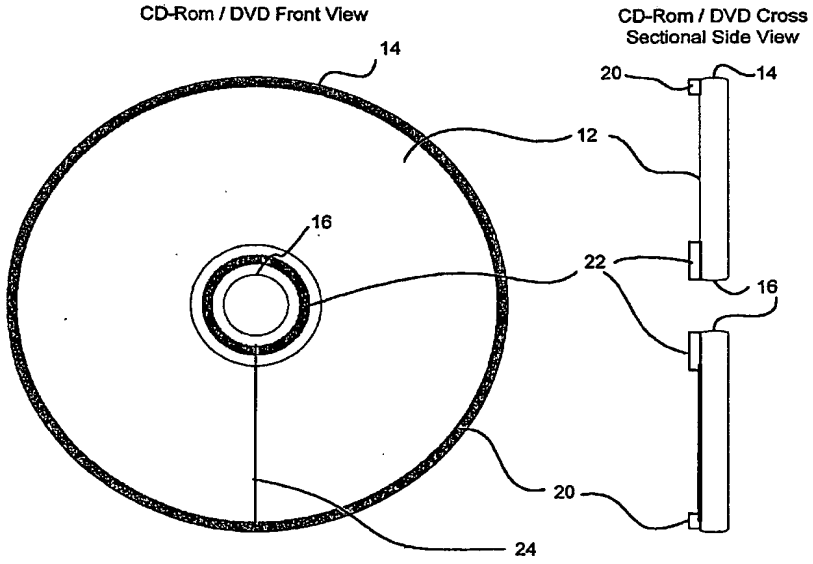
(54) Title: A METHOD AND APPARATUS FOR ENHANCING PERFORMANCE OF AN RFID TAG FOR A COMPACT DISC



(57) Abstract: An apparatus for enhancing the performance of an RFID tag for a compact disk (12) having an inner perimeter and an outer perimeter, the apparatus comprising: a first electrically conductive coil (20) attached to the outer perimeter (14) of the compact disk; a second electrically conductive coil (22) attached to the inner perimeter (16) of the compact disk; and an electrical interconnect (24) electrically connecting the first electrically conductive coil (20) to the second electrically conductive coil (22); wherein the RFID tag is further attached onto the compact disk (12) in close proximity to the second electrically conductive coil (22).

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A METHOD AND APPARATUS FOR ENHANCING PERFORMANCE OF AN RFID TAG FOR A COMPACT DISC

BACKGROUND

[001] Figure 1. depicts a typical RFID system setup whereby a RFID reader/writer is connected to one or multiple antennas. These antennas radiate the electrical RF energy from the reader/writer as electro-magnetic RF energy. RFID tags passing through the electro-magnetic field will derive power from the field and power up. If sufficient power is received, the tags are then ready for operation.

[002] Figure 2. depicts a typical RFID tag which basically consists of a RFID chip connected to an antenna coil. In a typical RFID system operating at a nominal frequency of 13.56Mhz, the resonance frequency of such a RFID tag will be 13.56Mhz +/- 500Khz for optimum performance.

[003] Figure 3. shows the interaction of the RF field lines with a RFID tag on a non-ferrous object. As the object being tagged is non-ferrous, the electro-magnetic field lines are not impeded and therefore the RFID tag can function normally.

[004] Figure 4. depicts a RFID tag attached to a typical CD / DVD. As CDs / DVDs contain a layer of metallization forming the reflective surface, attempts to attach a RFID tag to such media have given dismal performance. This is due to the detuning of the tag due to the tag's close proximity to the metallic layer and the attenuation of the field by the metallic layer. The metallic layer also lowers the 'Q' factor of the coil of the RFID tag, causing loss of range. In attempts to avoid the metallic layer, RFID tags have been made to fit the inner ring of such CDs/DVDs (hereinafter, the term **compact disks** will be used to describe such CDs and DVDs as well as other formats of similar optical disks with such metallization surfaces on the optical disk). Although this avoided the detuning of the tag, its small size limited its performance.

[005] Figure 5. shows the effect of a RFID tagged compact disk in the RF electro-magnetic field. The eddy currents in the metallic layer reflect most of the energy and only

a small percentage of the field lines go though the tag. As the metallic layer is thin, some field lines will go though the metallic layer but these will be greatly attenuated.

[006] The performance of RFID tags on compact disk have posed a major problem for many RFID systems. In typical RFID systems operating on 13.56Mhz, for a RFID tag of 3cm diameter, read / write range can drop by up to 30% after being attached to a compact disk.

SUMMARY OF THE INVENTION

[007] The present invention seeks to provide a method and apparatus for enhancing performance of an RFID Tag for a compact disk.

[008] Accordingly, in one aspect, the present invention provides, an apparatus for enhancing the performance of an RFID tag for a compact disk having an inner perimeter and an outer perimeter, the apparatus comprising: a first electrically conductive coil attached to the outer perimeter of the compact disk; a second electrically conductive coil attached to the inner perimeter of the compact disk; and an electrical interconnect electrically connecting the first electrically conductive coil to the second electrically conductive coil; wherein the RFID tag is further attached onto the compact disk and in close proximity to the second electrically conductive coil.

[009] In another aspect of the invention, a method for enhancing the performance of an RFID tag for a compact disk having an inner perimeter and an outer perimeter, comprising the steps: attaching a first electrically conductive coil to the compact disk; attaching a second electrically conductive coil to the compact disk; electrically connecting the first electrically conductive coil to the second electrically conductive coil; and attaching the RFID tag to the compact disk; wherein the RFID tag is in close proximity but not in direct contact with the second electrically conductive coil.

[0010] In yet a further aspect of the present invention, A method for enhancing the range of an RFID tag having a coiled antenna when operating with an RFID tag reader/writer,

steps comprising: electrically connecting a first electrically conductive coil to a second electrically conductive coil using a interconnect; positioning the coiled antenna of the RFID tag in proximity with the second electrically conductive coil; and positioning the first electrically conductive coil within range of the RFID tag reader/writer.

DESCRIPTION OF THE INVENTION

[0011] Figure 6. shows the present invention of an apparatus for enhancing the performance of an RFID tag for a compact disc 12. A first electrically conductive coil or an outer coil 20 of nominally two to three turns is closely wound and attached to an outer perimeter 14 of the compact disk 12. A second electrically conductive coil or an inner coil 22 of nominally five to six turns is loosely wound and attached to the non-metallic inner ring 16 or inner perimeter of the compact disk 12. The inner coil 22 is then electrically connected to the outer coil 20 via an interconnect 24. The polarity of the inner coil 22 is in phase with the polarity of the outer coil 20. Parasitic capacitance of both the inner coil 22 and the outer coil 20 can cause the both the coils to self resonate. For optimum performance in nominally 13.56Mhz RFID systems, the coils should have a self resonant frequency of typically 15Mhz. This optimum frequency can vary depending on the coupling factor between the inner coil and the RFID tag.

[0012] Figure 7. shows the electrical equivalent of the invention. As coils with larger diameters pick up more energy when subjected to an electro-magnetic field, the outer coil 20 which is larger in diameter is the main energy pick-up coil. This will induce a RF voltage in the outer coil 20. This voltage is also connected to the inner coil 22 which is smaller in diameter. With the same voltage across the inner coil 22, but with a smaller diameter, the inner coil 22 will thus generate a denser electro-magnetic field around it. The RFID tag, being in close proximity to the inner coil 22, will receive higher electro-magnetic field strength. The overall effect is the RFID tag 'acquiring' a larger diameter. The outer coil 20 and the inner coil 22 will resonate at a certain frequency due parasitic capacitance of both coils. This frequency has to be higher than the RFID tags' operating

frequency as the RFID tag is in close proximity to the inner coil, the combined resonance will be lowered.

[0013] Figure 8. shows the RFID tag 30 together with the apparatus in accordance with the present invention. The outer coil 20 and the inner coil 22 are wound such that when the compact disk 12 is spun at high revolutions, the entire assembly of the compact disk 12 and the apparatus of the present invention are balanced and does not cause the compact disk 12 to wobble. If the attachment of the RFID tag 30 onto the compact disk 30 causes the compact disk 30 to be unbalanced and to wobble, the positions of the apparatus of the present invention can be adjusted to compensate for the unbalanced RFID tag 30. This balances out the compact disk 30, much like adding weights to vehicle tyres.

[0014] Using a small RFID tag on the inner ring of a compact disk 12 will have limited range. However, a large RFID tag on the metallic layer will result in low 'Q' and may be detuned by the metallic layer, therefore will also have a limited range. This present invention 'extends' the range of a small RFID tag 30 on the inner ring of the compact disk 12 to that of a larger RFID tag. The present invention also prevents the loss of 'Q' associated with larger tags as the RFID tag is only loosely coupled to the inner coil. Therefore, even if the inner and outer coil is of low 'Q', the effect on the overall 'Q' factor of the RFID tag is negligible.

[0015] The present invention can extend the range of RF or RFID tags on compact disks or other objects with metallic coatings. Referring to FIGURE 9, a 3cm diameter RFID tag is tested on a typical RFID system operating on 13.56Mhz. The tag alone had an operating range of 35cm from the reader antenna. After this tag is attached to a compact disk, the range dropped to 30cm. The same tag was then attached to a CD with the apparatus of the present invention, the range was extended to 80cm.

[0016] As the apparatus of the invention is a fully passive device (does not need a power supply) and is extremely reliable, it can be adhered or attached to the metallic side of the compact disk. The RFID tag 30 can then be adhered to the apparatus of the present invention. In event the RFID tag 30 fails, the RFID tag 30 can be removed and replaced. If a larger RFID tag is used and it fails, the removal of the large RFID tag may damage the

metallic layer of the compact disk, permanently destroying the compact disk. Therefore, this invention allows small RFID tags to perform like larger tags without the problems introduced by larger tags.

[0017] This invention also allows the routing and harvesting of electro-magnetic energy and re-emitting it on a focused area, much like a magnifying glass with sunlight. This has been shown here as a RFID Tag on a compact disk. The outer coil 20 collects the energy and the inner coil 22 re-emits it on a smaller area, focusing and increasing the energy density. Therefore, this invention further allows a coil antenna of an RFID tag not to be within the direct range of a RFID tag reader/writer. Applying this to other types of products not limited to compact disks, an outer coil 20 having a large diameter can be electrically connected to a inner coil 22 via an interconnect 24. The interconnect 24 may be of a predetermined length which results in the inner coil 22 being out of range from a RFID tag reader/writer. An RFID tag is then mounted or attached in a position whereby the RFID tag is in close proximity to the inner coil 22. The outer coil 20 is then positioned or placed in range of the RFID tag reader/writer thus allowing the RFID tag to be operable with the RFID tag reader/writer even if the RFID tag is not within range of the RFID tag reader/writer.

[0018] The present invention extends the operating range of RF / RFID tags by 'virtually' enlarging the size of the tags' coil without physical connection to the tags' coil.

[0019] The thin and light physical characteristic of the invention, as well as it is balanced, does not impede the operation of the compact disk. It also provides an avenue to offset any imbalance caused by the RFID tag.

CLAIMS

1. A method for enhancing the performance of an RFID tag for a compact disk having an inner perimeter and an outer perimeter, comprising the steps:

a. attaching a first electrically conductive coil to said compact disk;

b. attaching a second electrically conductive coil to said compact disk;

c. electrically connecting said first electrically conductive coil to said second electrically conductive coil; and

d. attaching said RFID tag to said compact disk;

wherein said RFID tag is in close proximity but not in direct contact with said second electrically conductive coil.

2. The method in accordance with claim 1, wherein said first electrically conductive coil is attached to said outer perimeter of said compact disk.

3. The method in accordance with claim 2, wherein said first electrically conductive coil has a diameter substantially similar to diameter of said compact disk.

4. The method in accordance with claim 1, wherein said second electrically conductive coil is attached to said inner perimeter of said compact disk.

5. The method in accordance with claim 1, wherein said first electrically conductive coil is connected in phase with said second electrically conductive coil.

6. The method in accordance with claim 1, wherein said first electrically conductive coil may be re-positioned to provide balancing for said compact disk.

7. The method in accordance with claim 1, wherein said second electrically conductive coil may be re-positioned to provide balancing for said compact disk.

8. An apparatus for enhancing the performance of an RFID tag for a compact disk having an inner perimeter and an outer perimeter, said apparatus comprising:

a first electrically conductive coil attached to said outer perimeter of said compact disk;

a second electrically conductive coil attached to said inner perimeter of said compact disk; and

an electrical interconnect electrically connecting said first electrically conductive coil to said second electrically conductive coil;

wherein said RFID tag is further attached onto said compact disk and in close proximity to said RFID tag.

9. The apparatus in accordance with claim 8, wherein said first electrically conductive coil is connected in phase with said second electrically conductive coil.

10. The apparatus in accordance with claim 8, wherein said first electrically conductive coil may be re-positioned to provide balancing for said compact disk.

11. The apparatus in accordance with claim 8, wherein said second electrically conductive coil may be re-positioned to provide balancing for said compact disk.

12. A method for enhancing the range of an RFID tag having a coiled antenna when operating with an RFID tag reader/writer, steps comprising:

a. electrically connecting a first electrically conductive coil to a second electrically conductive coil using a interconnect;
b. positioning said coiled antenna of said RFID tag in proximity with said second electrically conductive coil; and
c. positioning said first electrically conductive coil within range of said RFID tag reader/writer.

13. The method in accordance with claim 12, wherein said first electrically conductive coil is connected in phase with said second electrically conductive coil.

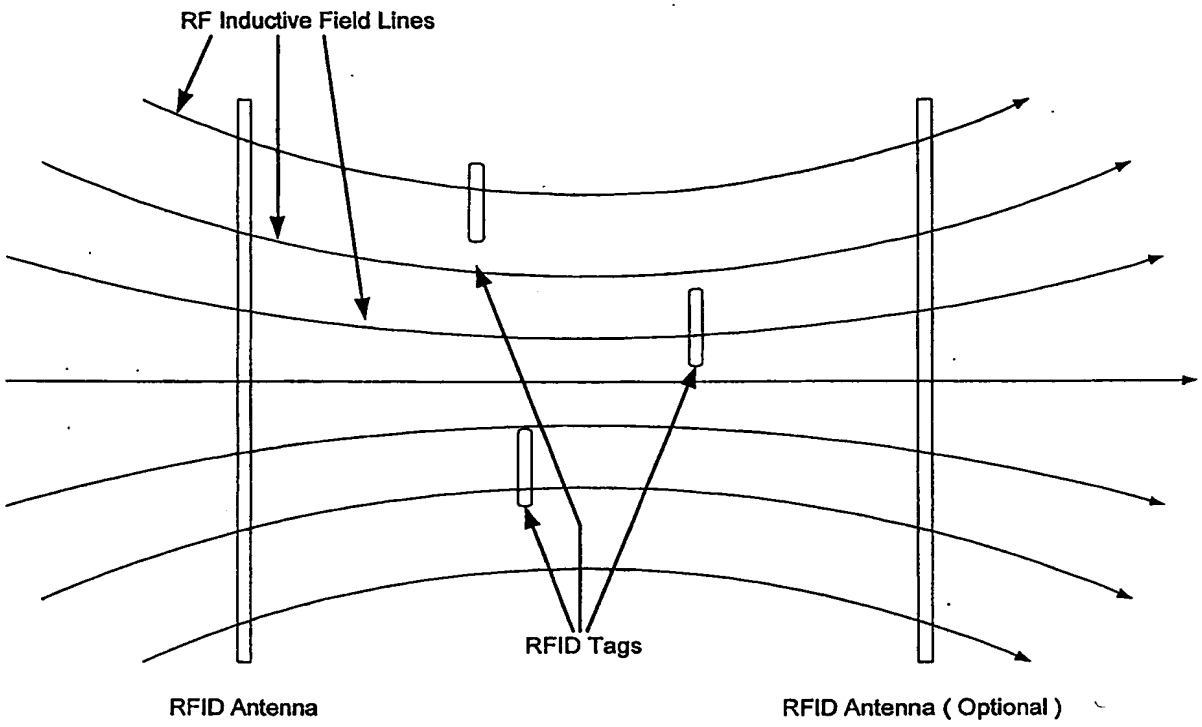

FIGURE 1.

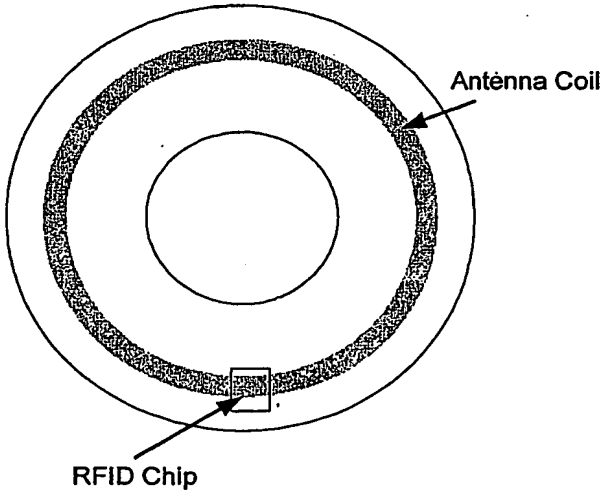

FIGURE 2.

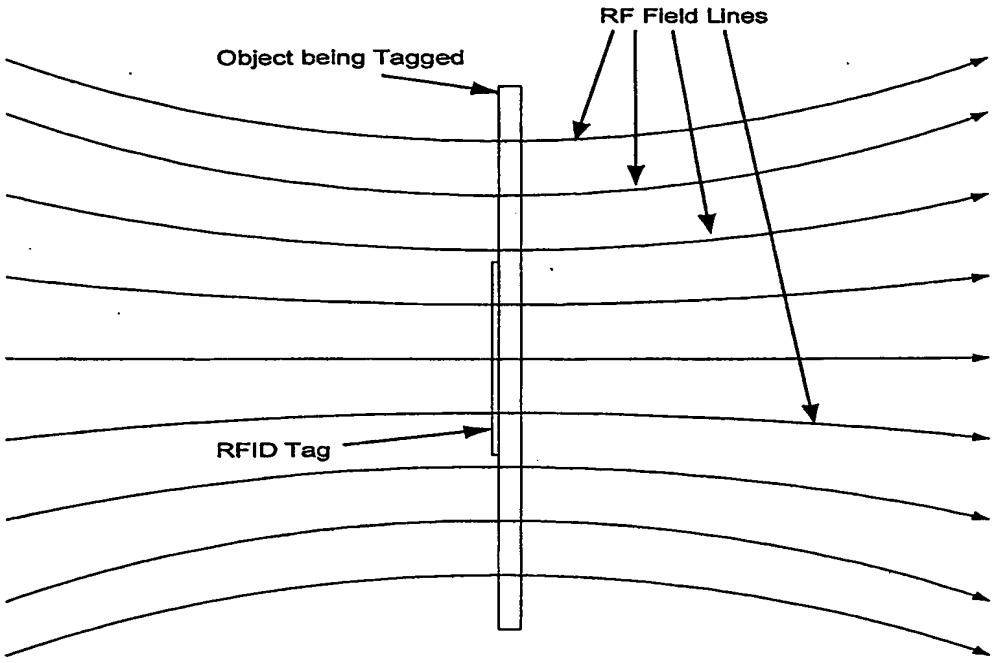

FIGURE 3.

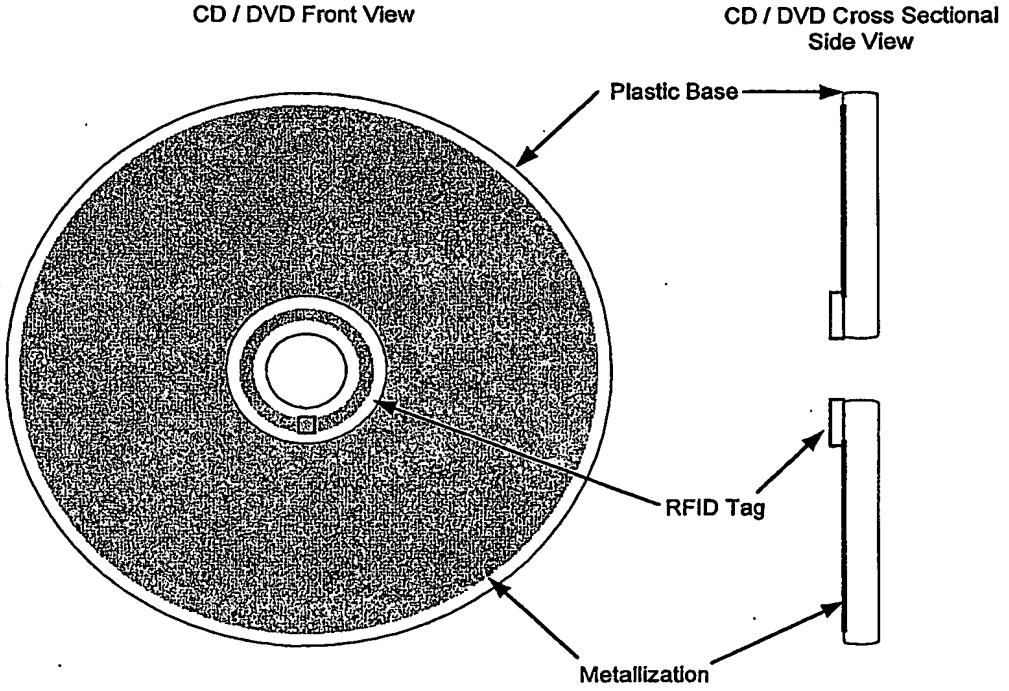

FIGURE 4.

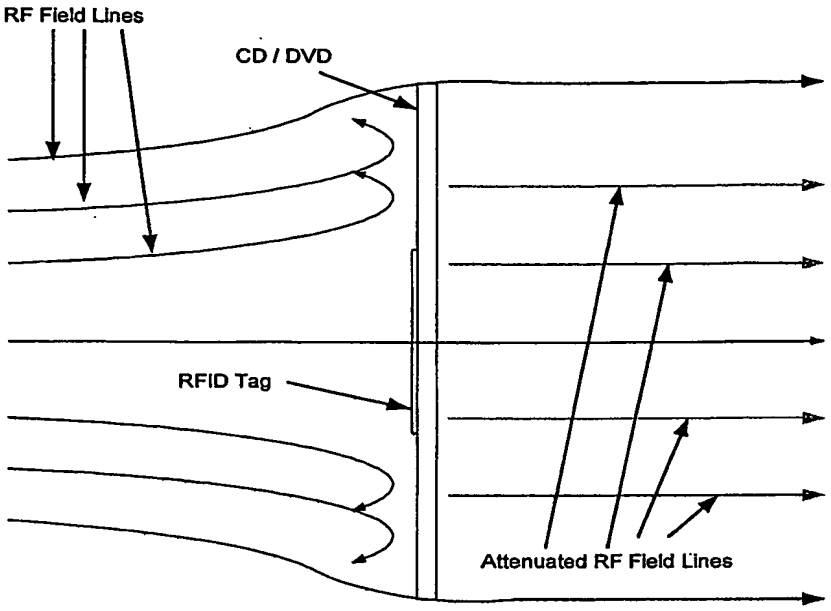

FIGURE 5.

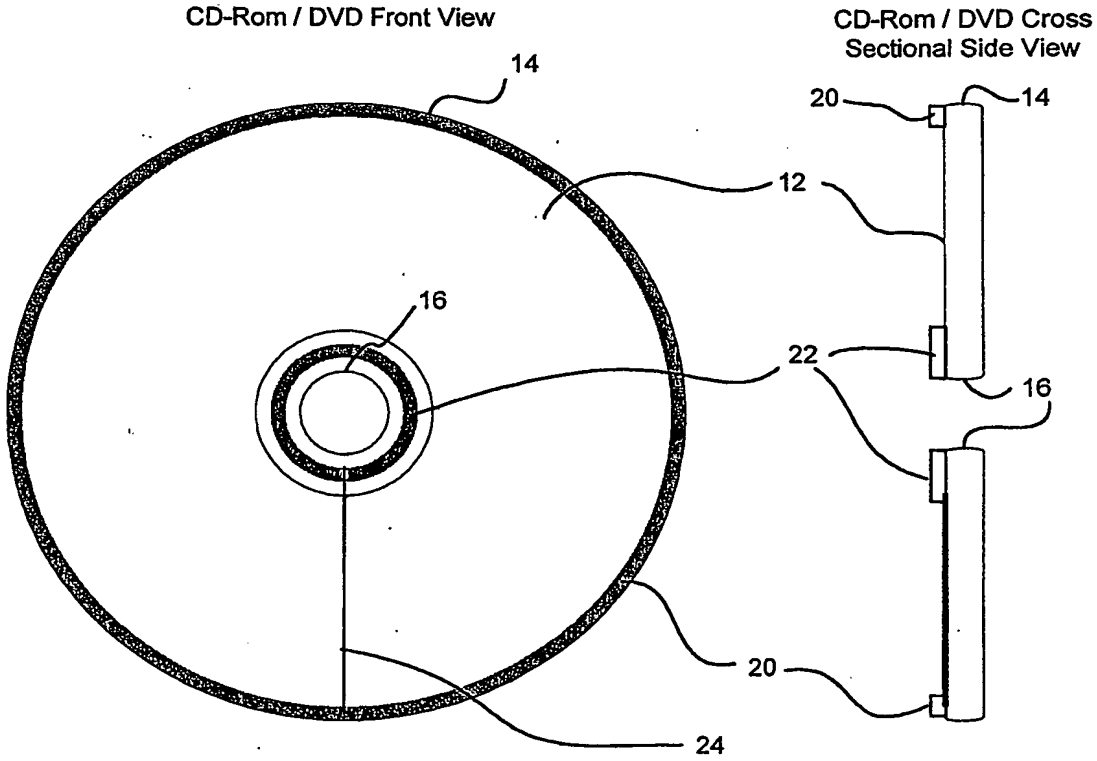

FIGURE 6.

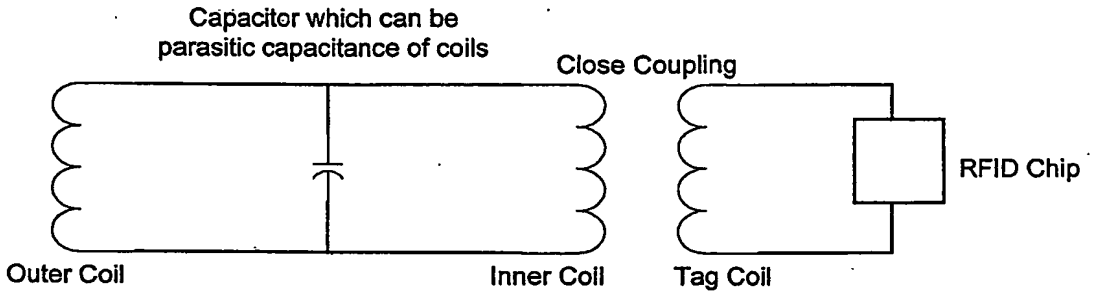

FIGURE 7.

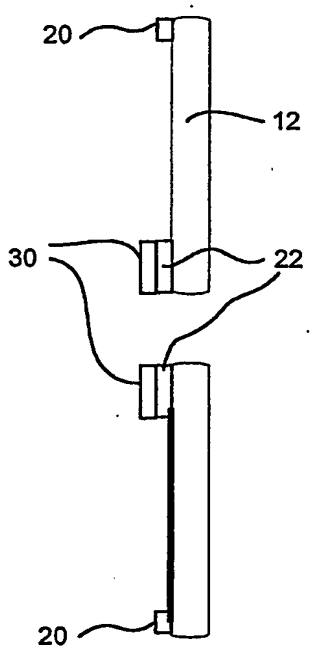

FIGURE 8.

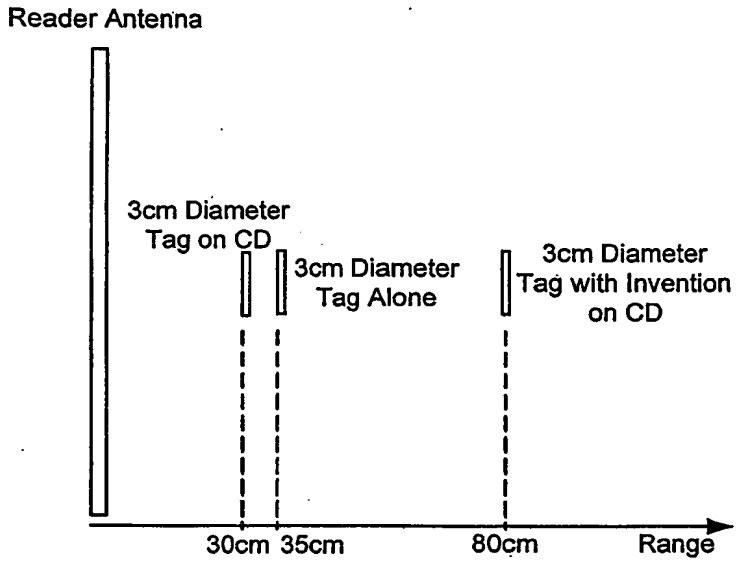
Reader Antenna
3cm Diameter
Tag on CD
3cm Diameter
Tag Alone
3cm Diameter
Tag with Invention
on CD
30cm
35cm
80cm
Range

FIGURE 9.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG2004/000117

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: G01V 15/00, G08B 13/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI & keywords: rfid, radio frequency tag; cd, dvd, optical disc; coil; perimeter, circumference, periphery; metal, conductive; and other similar terms. PAJ: rfid; repeater, range and other similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, E	WO 2004/046762 A1 (SMARTAG(S) PTE LTD) 3 June 2004 see page 9 paragraph [0033] - page 12 paragraph [0045]	1 - 13
X	US 2002/0021208 A1 (NICHOLSON et al.) 21 February 2002 See paragraphs [0025] – [0052]	12, 13
X	JP 2002-319009 A (HANEX CHUO KENKYUSHO:KK) 31 October 2002 [online machine translation][retrieved on 05-06-2004]. Retrieved from the internet: <URL: http://www4.ipdl.jpo.go.jp/Tokujitu/PAJdetail.ipdl?N0000=60&N0120=01&N2001=2 &N3001=2002-319009> See abstract and paragraphs [0014] – [0021]	1 - 13

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 June 2004	21 JUL 2004
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **RAJEEV DESHMUKH** Telephone No : (02) 6283 2145

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG2004/000117

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 347 508 A (MONTBRIAND ET AL.) 13 September 1994 see entire document	1 - 13
A	Patent Abstracts of Japan JP 2003-085502 (HITACHI CHEM CO LTD) 20 March 2003 see abstract	1 - 13
A	WO 2000/023994 A1 (INTERMEC IP CORP.) 27 April 2000 see entire document	1 - 13
A	Derwent Abstract Accession No. 2003-450899/43, Class T03, EP 1302893 A1 (X-IDENT GMBH) 16 April 2003 see abstract	1 - 13

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SG2004/000117

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	2004046762						
US	2002021208	AU	83216/01	AU	83555/01	AU	84768/01
		CA	2419088	CA	2419116	CA	2425597
		CA	2452282	EP	1323144	EP	1325480
		EP	1328912	EP	1377945	US	6445297
		US	6517561	US	2002041233	US	2002130778
		US	2004046663	WO	0215112	WO	0215139
		WO	0231789	WO	02075684		
JP	2002319009						
US	5347508	AU	35396/93	CA	2092358	EP	0567080
		JP	6044738				
JP	2003085502						
WO	0023994						
EP	1302893	DE	10150458				

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX